DEEP-SEA FISHES OF THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

Family DERICHTHYIDAE[1]

William Beebe

(Figs. 1-9 incl.)

Contents

INTRODUCTION

For detailed data of nets, locality, dates, etc., concerning the capture of the deep-sea eels treated in this monograph, refer to Zoologica, Vol. XIII, Nos. 1, 2 and 3, and for physical data, methods of measurement and definitions of growth stages see Zoologica, Vol. XVI, No. 1. The accounts of deep-sea fishes directly preceding the present paper comprise Zoologica, Vol. XVI, Nos. 2, 3 and 4. Reports on the other families of eels are approaching completion and will appear shortly, together with a survey of the Order and a complete résumé of present knowledge of the evolution of deep-sea eels.

All the material under consideration was taken in the course of 1,350 nets drawn in one locality, an eight-mile circle, with its

[1] Contribution No. 478, Department of Tropical Research, New York Zoological Society.

Fig. 1. *Derichthys serpentinus.* A photograph of the head of an adult female, showing pores and striations. (x 2.6).

center at 32° 12′ North Latitude and 64° 36′ West Longitude, nine and a quarter miles south-southeast of Nonsuch Island, Bermuda. Vertically this is an imaginary cylinder, considered as extending from the surface to the bottom of the sea, an extreme range of 1,500 fathoms. Six silk metre-nets were used, strung at exact intervals along two miles of wire, drawn at an angle of 30 degrees, at the rate of two knots an hour.

In the present work I have had the cooperation of my entire staff. Mr. John Tee-Van supervised the capture of the deep-sea fish. Miss Gloria Hollister cleared and stained specimens for osteological study. Miss Jocelyn Crane's part in these papers is rather that of co-author than of an able assistant; I owe to her the elaboration of the great mass of details. The drawings are the work of Mr. George Swanson.

Family DERICHTHYIDAE Gill 1884

Body anguilliform, slender; anus before or behind mid-body; scales absent, skin smooth; lateral line distinct; head

oblong, oval; eyes in anterior part of head, well developed; nostrils dorso-lateral or lateral, neither pair tubular; mouth with cleft little oblique, extending at least to posterior part of eye; jaws strong; maxillaries flattened, firmly articulated with the expanded pre-vomer; teeth conical, on jaws and vomer; branchial apertures small, lateral or oblique slits in front of or below pectorals, well separated; dorsal commencing behind head; anal origin before or behind middle of body; caudal, when present, confluent with dorsal and anal; membranes of vertical fins thick. Trewavas (1932, p. 641) has shown that the structure of the upper jaw in *Derichthys* is essentially similar to that of other eels, definitely abolishing the order Carencheli. Three genera.

Key to the Genera

A. Anal origin at or behind middle of body, far behind dorsal origin (deep-sea, Atlantic) ..... *Derichthys* Gill 1884

AA. Anal origin well in advance of middle of body, slightly behind dorsal origin.

B. Caudal fin present (deep-sea, Philippines) *Benthenchelys* Fowler 1934

BB. Caudal fin absent (shallow water, Panama) *Gorgasia* Meek & Hildebrand 1923

Genus **Derichthys** Gill 1884

With the characteristics of the family. A neck-like constriction between head and pectoral fins; anus sub-median, slightly behind middle of body; dorsal, anal and caudal confluent.

It seems almost certain that only one of the three described species is valid. I agree with Parr (1934 p. 33 ff.) that there is no reason for maintaining *D. iselini* Borodin 1929 as distinct from *D. serpentinus*. As Parr points out, there is not one of the so-called differences between the species which cannot properly be laid to the incomplete descriptions and bad preservation of the type of *D. serpentinus*, while the terminal, tubular "nostrils" of *D. iselini* are unquestionably merely sensory pores in advance of the true anterior nostrils. They are very prominent in all the Bermuda specimens.

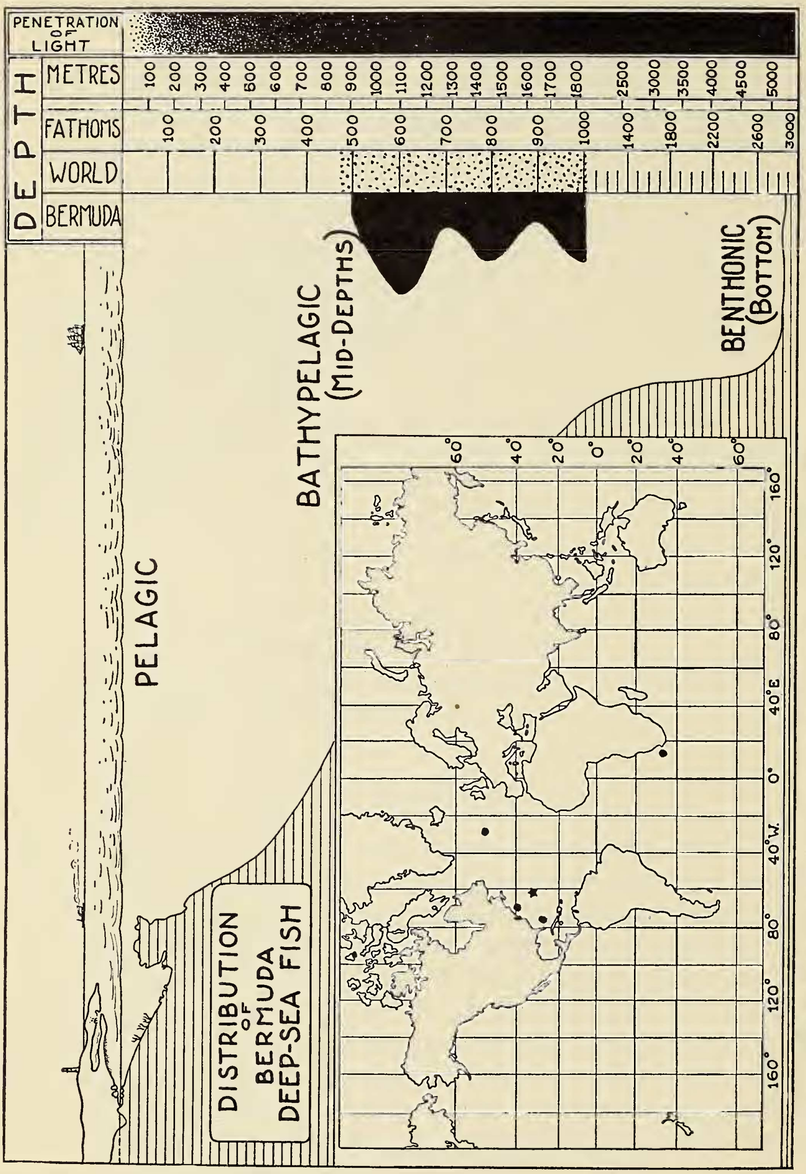

Fig. 2. The geographic and vertical distribution of *Derichthys serpentinus*. The relative number of specimens taken at different depths by the Bermuda Oceanographic Expeditions is shown diagrammatically at the left of the column which gives the vertical range of the genus.

In addition I am synonymizing *D. kempi* (Norman 1930) with *D. serpentinus,* as our Bermuda examples agree perfectly, except for the unpaired frontals (see p. 9), with the descriptions and figures of the specimen from the South Atlantic.

Derichthys serpentinus Gill 1884

Specimens Taken by the Bermuda Oceanographic Expeditions

Eighteen specimens; June to September, 1929 to 1931; 500 to 1,000 fathoms; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard lengths from 55 to 268 mm.

Specimens Previously Recorded

Four specimens; 1,000-0 fathoms; West Indies, North Atlantic and South Atlantic off Cape Town; recorded standard lengths from 160 to 200 mm. (Fig. 2).

Description of Adult

Color (fresh specimens) : (Figs. 1, 3C, 4C). Tawny olive to mouse gray, with glints of bluish sheen on the neck; fins lightly pigmented but almost transparent; midway of each web in the largest specimens is an oval, opaque, whitish patch, possibly luminous; these patches are invisible in preserved fish.

Proportions: Depth in length 16.5 to 22; head in length 6.5 to 8.5; head minus neck[2] in length 11.3 to 15; eye in head 7.3 to 8.8 (covered by skin) ; eye in head without neck 4 to 5.2; snout in head 5.5 to 6.5; snout in head minus neck 3.2 to 3.6; snout to dorsal origin in length 3.8 to 4; snout to anal origin in length 1.8 to 1.9.

Teeth: Small, conical, in three to five irregular rows on both jaws, dying out posteriorly. The pre-vomerine band is continuous with that of the maxillary, and also consists of three to

[2] Neck measured from first lateral line pore to posterior end of gill-slit.

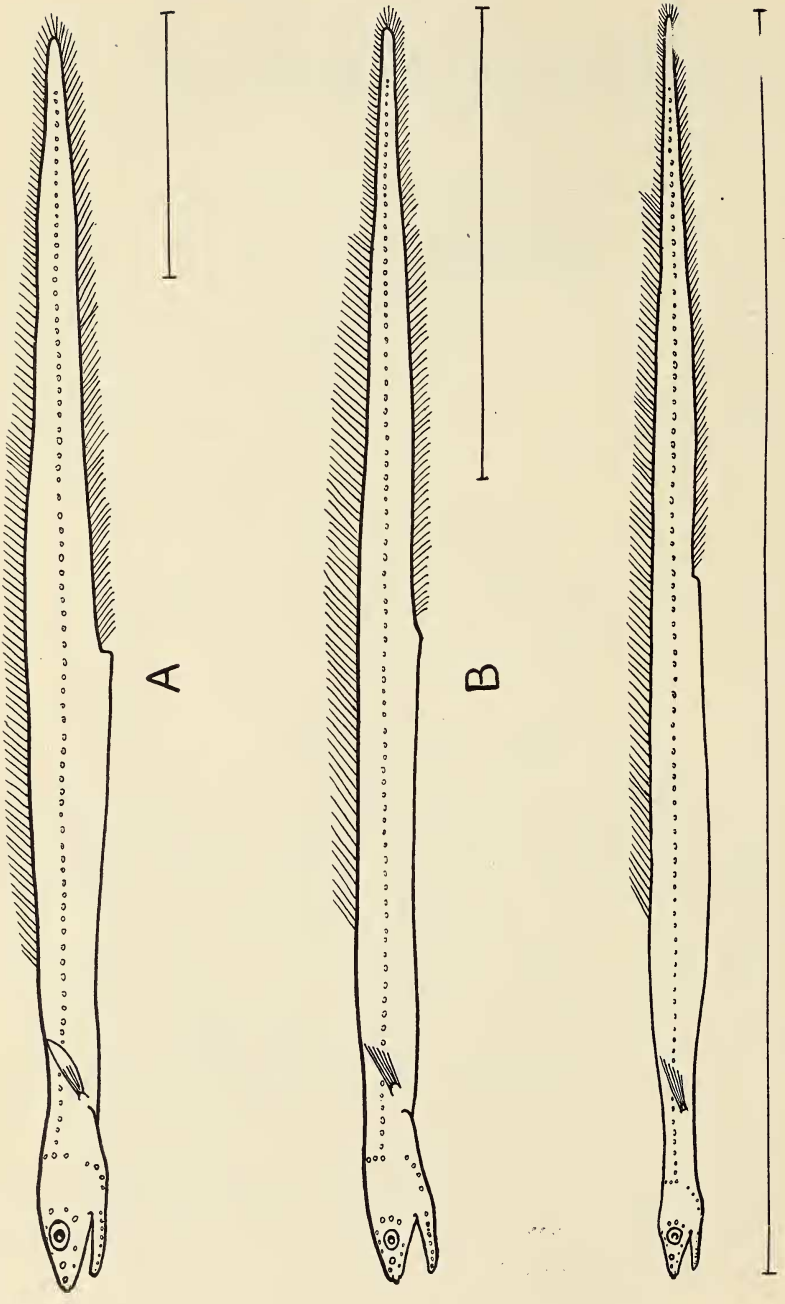

Fig. 3. *Derichthys serpentinus.* A, adolescent, 58 mm.; B, transitional adolescent, 98 mm.; C, adult, 268 mm. The relative size of the specimens is indicated by the straight lines.

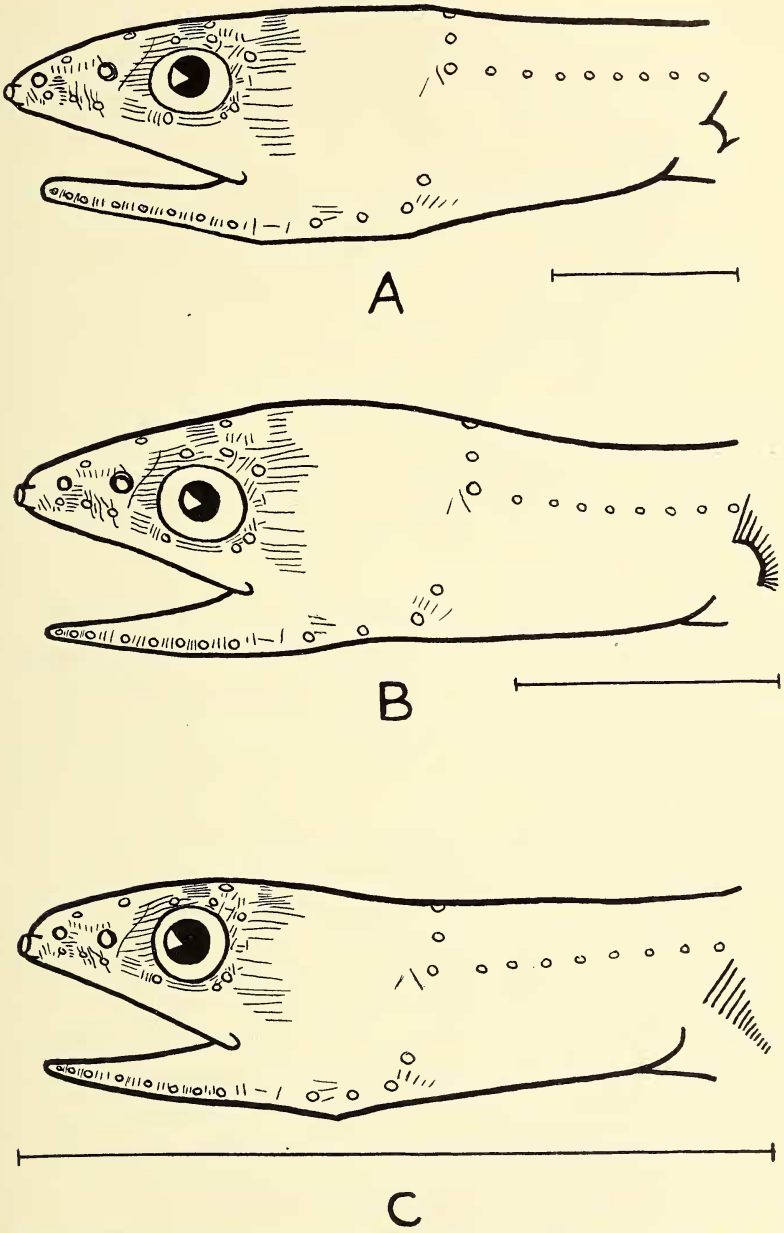

Fig. 4. Heads of *Derichthys serpentinus*. A, adolescent, standard length 58 mm.; B, transitional adolescent, standard length 98 mm.; C, adult, standard length 268 mm. The relative size of the specimens is indicated by the straight lines.

five rows. There is a horseshoe-shaped group on the vomer proper, separated from the pre-vomerine group; the horseshoe is composed of an anterior mass of about a dozen teeth, the inner ones sometimes rudimentary, and two posteriorly directed rows of five to ten teeth each.

FINS: Pectoral 13, slightly longer than the combined lengths of snout and eye. Dorsal 226 to 256, originating at a point about one-fifth of the length of the fish from snout; the posterior dorsal rays, occupying about the last third of the caudal peduncle, are abruptly shorter, less than half as long as the others. Anal 155 to 180, beginning at or immediately behind the middle of the body, its rays much shorter than the anterior dorsal rays. Caudal short, less than diameter of eye, rounded, confluent with dorsal and anal; 10 true caudal rays.

NOSTRILS: Both nostrils are situated dorso-laterally, dividing the snout into almost equal thirds; the posterior one is about a third again as large as the anterior.

PORES AND LATERAL LINE: On the head the pores are arranged in the following characteristic manner: Tip of snout, one pair, very large, tubular, directed forwards or slightly upwards (this was mistaken for a pair of nostrils in the type description of *Derichthys iselini*); above each anterior nostril, two small pores; below same, one small pore; on each side of snout profile, above posterior nostrils, one pore, moderate; above each orbit, three; on each side of top of crown near level of posterior border of eye, one; on each side of snout, behind anterior nostril, two; below anterior corner of orbit, one; below posterior corner of orbit, two; along mandible to end of gape, eight; continuing this line posteriorly to level of lateral line origin, four, the fourth above and slightly behind the third; between the first lateral line pores of each side, extending dorsally along the boundary between head and neck, three (one being median). In addition to these pores, the head is also conspicuously marked with equally characteristic groups of embossed striations. The lines of each group are parallel, some groups being horizontal, some vertical; usually there are six or seven lines in a group (Fig. 4). The most posterior groups are located close behind the eye, with the exception of an inconspicuous series a short distance behind the pectorals. The striations are probably associated with

the lateral line system. The lateral line begins at the same level as the "neck," well in front of the pectoral. For a short distance it runs near the dorsal profile, but soon descends to the mid-line, which it subsequently follows. There are 80 to 90 pores, all slightly tubular, stopping at a little more than a head's length in front of the caudal base. The course of the lateral line between the pores can be traced by a prominent ridge.

MYOMERES AND VERTEBRAE: 126 to 130.

BRANCHIOSTEGALS: 7.

OSTEOLOGY: The general skeletal characters of *Derichthys* may be summarized as follows: An expanded, dentigerous prevomer united with the vomer by a narrow isthmus; frontals fused or ankylosed; supraoccipital present; palato-pterygoid slender, vestigial; four pectoral radials; ribs absent; caudal vertebrae without lateral transverse processes in addition to the haemal arches. The following detailed description is derived from a cleared and stained adult female, 268 mm. long, in the Bermuda collection.

The entire skeleton is fairly well ossified with the exception of the posterior rays of the vertical fins and the major part of the vertebral column. Only toward the tip of the tail do the centra show more than faint traces of stain. These last vertebrae, however, along with the jaws and components of the hyoid and branchial arches, are the most strongly ossified bones in the body.

Skull: (Fig. 5). Although the skull has not taken up much of the scarlet stain, still it is unquestionably well ossified, as it is very firm. The most striking characteristic of the skull and of the entire head as well is the prevalence of consolidated bones. The frontals are ankylosed; the hyomandibular, quadrate and preopercle are fused to form a single unit, and there is no hint of a separate articular or angular.

Unlike Trewavas's specimen from South Africa (Trewavas, 1932, p. 641), in which the frontals were united by suture, in all three of the cleared Bermuda specimens they are firmly ankylosed together, without a sign of division. They extend forward almost as far as the anterior margin of the orbit, and then bend downward behind the ethmoid, dying out just above the vomer itself. The parietals are more than equal to the frontals in area,

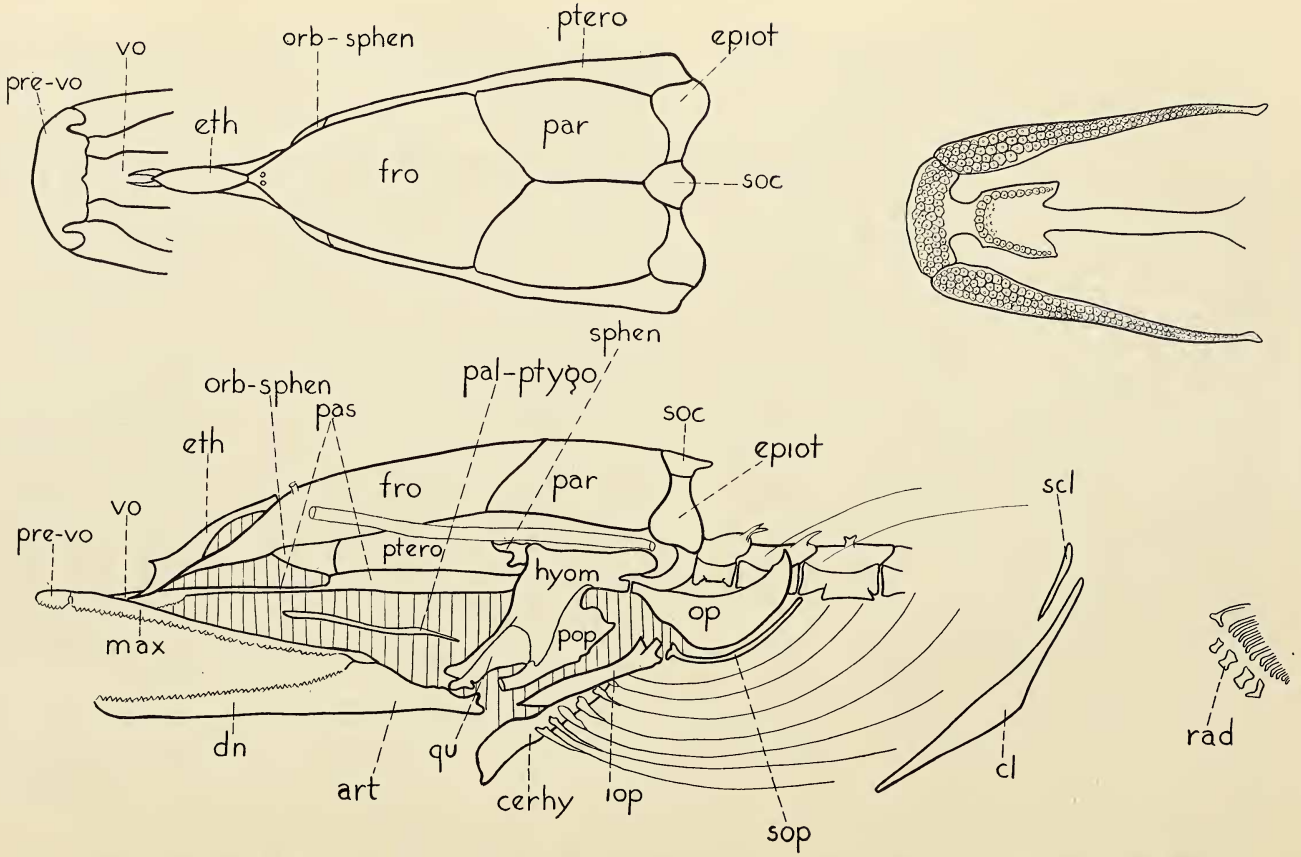

Fig. 5. *Derichthys serpentinus.* Bones of the head of adult female, standard length 268 mm. Upper left, dorsal view of skull; upper right, ventral view of upper jaw; lower, lateral view of head. (All x 5).

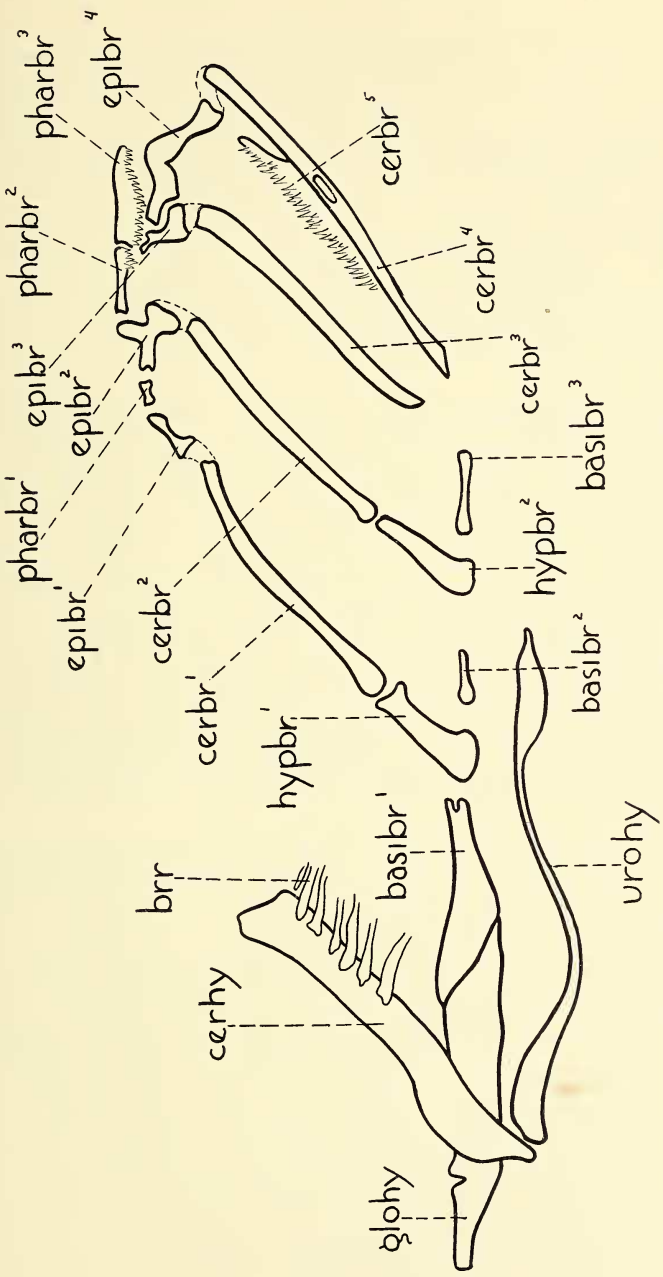

Fig. 6. *Derichthys serpentinus.* Hyoid and branchial arches of adult female, standard length 268 mm. (x 8.6).

though the epiotics, posterior to these, are only slightly larger than the tiny supraoccipital. The elongate pterotics, laterally placed, extend the full length of the parietals and more than half that of the frontals. Anterior to the pterotics are the triangular orbito-sphenoids. Below, the posterior half of the parasphenoid, much broadened, forms the anterior part of the floor of the brain-case, the unusual length of this bone and of the pterotic being necessitated by the forward position of the eye in connection with the elongation of the jaw. This also brings about the unusual separation of the orbito-sphenoid and the sphenotic, which is located slightly behind the junction of the frontal and parietal.

Palato-pterygoid Arcade: (Fig. 5). The hyomandibular is much fenestrated, and fused firmly with both the quadrate and preopercle. The upper anterior arm is short, articulating only a little behind the vertical from the anterior edge of the epiotics; a short projection from the ventral margin of the arm articulates with the opercle; the third arm, directed antero-ventrally, is fused to the inner face of the quadrate, only a rim of the bone projecting above it; this arm extends almost to the jaw angle. The quadrate, articulating with the undifferentiated angular, is short, and broad posteriorly. The palato-pterygoids, although well ossified, are of needle-like slenderness and seem to serve very little practical use as they do not connect directly with any bone.

Jaw Apparatus: (Fig. 5). The jaws and teeth are the most strongly ossified elements in the body. The "praemaxillary region of the praemaxilla-ethmo-vomer" of Trewavas (1932 p. 641) may be termed more conveniently the pre-vomer. In her specimen of 160 mm. from South Africa this bone is "united with the ethmo-vomerine region by a narrow isthmus." In Bermuda specimens both larger and smaller than hers, this isthmus, though very distinct, is unstained. The pre-vomer forms the entire front of the broad, obtuse snout and articulates with the maxillaries in close-fitting joints, a pair of grooves in the dorsal surface of the pre-vomer receiving a projection from each maxillary. The latter show broad ventral surfaces anteriorly, holding several rows of teeth; posteriorly, however, they are much attenuated. They reach well behind the posterior border of the

eye. The vomer proper is oblong, with the moderately broad, flat parasphenoid arising from its excavated posterior border. To its dorsal surface the forked end of the ethmoid is firmly attached by suture, and not ankylosed as in Trewavas's specimen. The ethmoid extends upward and backward, arching in its posterior part to form a foramen with the frontal, which it overlies throughout its length. The lower jaw is considerably shorter than the upper and about twice as deep, and extends a full third of its entire length behind the end of the maxillary. There are no lines of demarcation into articular and angular.

Opercular Apparatus: (Fig. 5). The preopercle is completely separated from the rest of the series, being fused to the ventral side of the hyomandibular by a large thin flange arising from the antero-dorsal side of the typically tubular portion of the bone. The interopercle is an elongate bar free from both preopercle and subopercle. The latter is very slender and almost crescentic, lying immediately beneath the horizontally placed opercle and following its curving outline. The opercle reaches the vertical from the middle of the second vertebra.

Hyoid Arch: (Fig. 6). There is no trace of an interhyal, and the epihyal and hypohyal elements are invisibly consolidated in the ceratohyal. There are seven branchiostegals, all arising from the posterior half of the ceratohyal, and all with more or less swollen bases. The seventh is very slender, is not attached directly to the ceratohyal, and reaches just beyond the opercle. The ceratohyal is attached about midway of the length of the glossohyal. The oblique posterior edge of the latter is joined by suture to the first basibranchial. The urohyal is a slender, curving bone swollen both basally and distally. It extends to the level of the second branchial arch.

Branchial Apparatus: (Fig. 6). There are three basibranchials, each separated from the preceding by more than its own length. The first is large, half the size of the glossohyal; the second is very small, slender; the third is again slightly longer, though still slender. In the first two arches hypobranchials are present. The first four ceratobranchials are all moderately slender, the first curved. The fifth is shorter than the rest and is attached to the inner anterior edge of the fourth, except at its dorsal posterior end. It bears several rows of sharp teeth, about

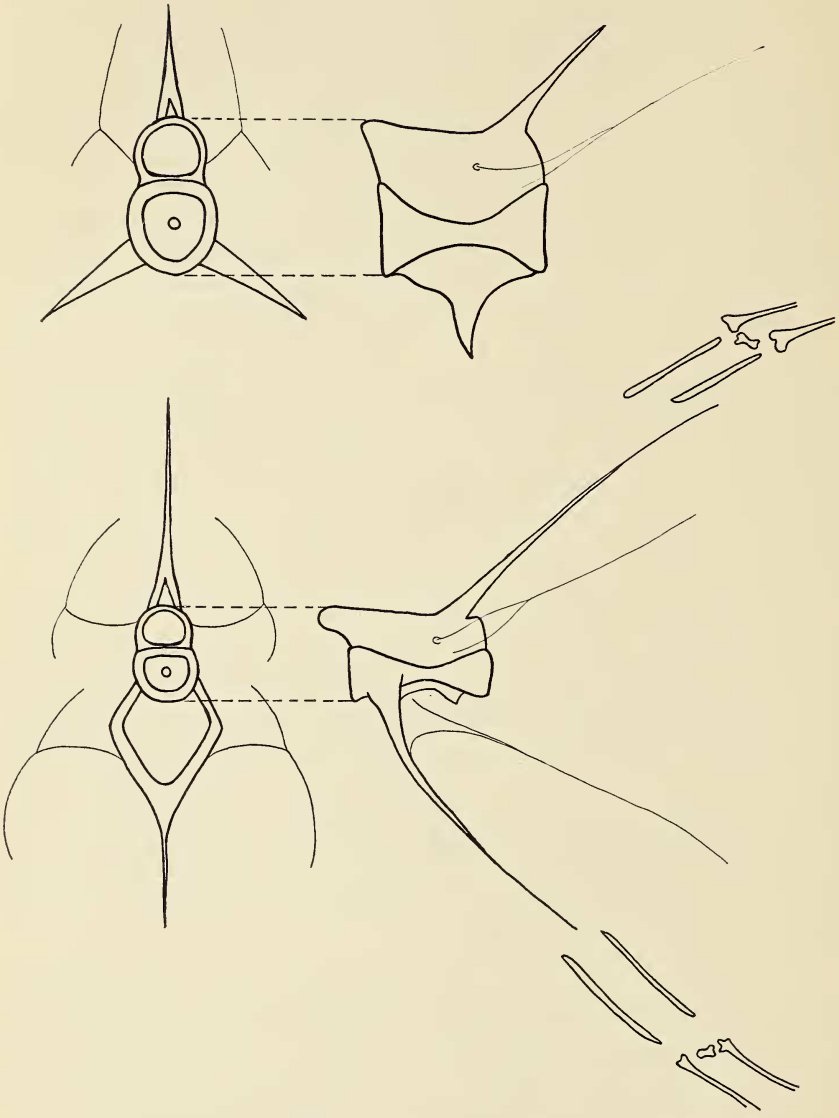

Fig. 7. *Derichthys serpentinus.* Vertebrae of adult female, standard length 268 mm. Upper, 15th vertebra (5th behind pectoral origin); lower, 62nd vertebra (6th behind anal origin). (Both x 8.8).

twenty-five in each row. There are four epibranchials of irregular shape. All are small, the fourth much larger than the others. The three pharyngobranchials increase in size posteriorly, teeth being present on the postero-ventral edge of the second and the entire ventral surface of the third. The apparatus has no connection with the vertebral column, and lies low in the branchial cavity.

Pectoral Girdle: (Fig. 5). The supracleithrum is located at the level of the sixth vertebra, half of its length projecting above the centrum. There is no connection with the column. The cleithrum is broad and strong, the center edge straight, the posterior convex. Its upper tip overlaps the lower half of the supracleithrum and is placed close behind it. Coracoids are absent. There are four radials, small but well ossified. The first of the thirteen pectoral rays is slightly separated from the others and has an enlarged base. The fin is far removed from the pectoral girdle.

Vertical Fins and Supports: (Fig. 7). The dorsal fin originates at the level of the 23rd vertebra, the anal at the 56th. The basal thirds of the rays of both fins are ossified as far back as the middle of the anal fin, but posterior to this neither dorsal nor anal shows any bony deposit. Baseosts are well developed, and show ossification more than a dozen rays behind the most posterior finray that shows any stain. The last, unossified baseosts have no definite terminations, each splaying out distally and merging with the adjacent elements, while the bases of the corresponding finrays are indistinguishably merged in the same web of cartilaginous tissue. There are usually two baseosts and rays to each vertebra. Tiny, horizontally placed radials also show faint ossification as far back as the rays, and can be differentiated slightly behind them.

Vertebral Column: (Fig. 7). The slight ossification of the centra and neural arches contrasts with the strongly stained vertebral appendages. Only the last 20 centra of the 130 vertebrae in the large female under discussion show more than traces of stain. The first vertebra is only half the size of the third, the second intermediate. The fourth is very slightly longer than the third, and this size is maintained until the origin of the anal

fin. From here to the tail there is the usual gradual decrease in size to the urostyle.

Throughout the column the neural arches are very large, equalling or exceeding the centra in height. Each arch interlocks with the one before by means of an anterior projection which underlaps the preceding posterior edge. The neural spines of the first nine vertebrae are diverse and specialized. The first is split longitudinally, one half falling immediately behind the other, and joined to it basally by suture. The pair is short, posteriorly directed, and arises at the posterior edge of the arch. The second spine is similar but single. The third, fourth and fifth arise from the anterior half of the arches and are short and forked, one prong behind the other. The sixth, at the level of the pectoral girdle, is represented only by a minute bump. The seventh is a small, posteriorly directed spine in the middle of the arch; the eighth is equal in size, but anteriorly directed; the ninth is low and again forked, arising from the posterior half of the arch. From the tenth to the column's end the spines are well developed, unforked, backwardly directed, and situated at the posterior end of the arch. They are longest in the region of the anterior part of the anal fin, where the length of each is more than twice that of neural arch and centrum combined. Near the caudal base they are relatively much reduced in size, but very strongly ossified. Epineurals, forked basally with only the inner prong attached to the neural arch, are present on every segment except the first and the specialized caudal vertebrae. They are ossified, however, only slightly beyond the middle of the anal fin, though their outlines are traceable almost to the caudal base.

The parapophyses are strong, short spines directed obliquely outward, their broad basal portions arising from the midst of the ventral halves of the centra. There is no trace of ribs. The first three haemal arches lie in front of the anus and lack all trace of haemal spines. Behind the anus, however, they promptly increase in length to equal that of the neural spines, the arches arising from the anterior part of the parapophyses. The first epipleural, an unattached sliver of bone, is found at the thirty-ninth vertebra, slightly behind the middle of the abdominal cavity. The succeeding ones increase in size posteriorly, the

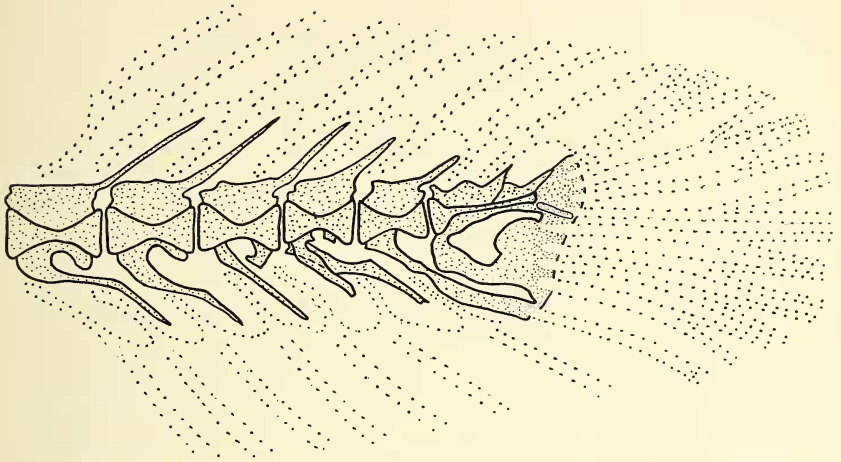

Fig. 8. *Derichthys serpentinus.* End of vertebral column and base of caudal fin in adult female, standard length 268 mm. (x 27.5).

tenth being the first with a forked base. At the origin of the anal (fifty-sixth vertebra) they attain their maximum size, and from here on correspond to the epineurals, ossification dying out similarly behind mid-anal. Their outlines, however, are traceable, like those of the epineurals, almost as far back as the specialized caudal vertebrae.

End of Vertebral Column and Caudal Fin: (Fig. 8). Two unusual characteristics of the tail structure of this eel are, first, the almost complete absence of osseous tissue, and second, the persistance of the neural arch and spines throughout the entire dorsal length of the urostyle. The only caudal specialization of centra, neural arches and spines is a gradual reduction in size. There is a radical change posteriorly in the haemal arches and spines. On the 125th or fifth pre-urostyle vertebra, the haemal arch base, in typical fashion, extends almost the full length of the centrum, narrowing in the center to form a well-marked bay with the proximal portion of the spine. Posteriorly the backward extension of the arch decreases and finally on the last vertebra disappears. There is no open arch on the penultimate vertebra, the two lateral elements being quite unjoined and very unlike.

The urostyle extends back as a straight rod for a length

greater than that of the preceding vertebra. On its dorsal surface it supports two well developed neural arches. At its end, and bounded above by the last neural spine, is the first hypural, supporting five caudal rays. Below is a larger cartilaginous area with an extensive central foramen, irregular but giving no definite hint marking a division into separate elements. So we must indicate the whole of this area as the second hypural, supporting the succeeding four caudal rays. The haemal spine of the last vertebra is extended backward into the long, slender third hypural from which arises the last and tenth caudal ray.

Pore System: The pores of the snout are supported by tiny bony tubules connected with unossified channels, while the lower jaw has a perforation corresponding to each pore in that area. Connection from both regions is made with the lateral line in the usual manner, via the post-temporal canal and the preopercle. The more posterior pores of the head and those of the neck and lateral line have no bony support.

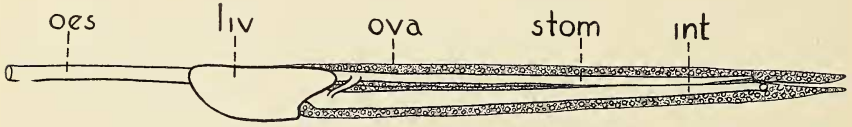

Fig. 9. *Derichthys serpentinus.* Digestive and reproductive systems in adult female, standard length 268 mm. (x 1.2).

DIGESTIVE SYSTEM: (Fig. 9). None of the digestive organs is pigmented, although the lining of the coelom has a thin scattering of chromatophores. The oesophagus opens directly into the stomach, slightly in front of the posterior tip of the liver. The stomach, very slender when not distended by food, barely reaches the anus, lying to the left of the equally slender intestine. The pyloric canal connecting the two organs has no caeca, extends obliquely forward. The liver is single-lobed, the left half the longer, and lies as usual ventral to the oesophagus and the oval gall bladder. The bile duct is short, entering the swollen pyloric region of the intestine at its most anterior point. The pancreatic tissue is practically indistinguishable from that of the liver.

REPRODUCTIVE SYSTEM: (Fig. 9). The ovaries originate at the level of about the middle of the liver and extend posteri-

orly against the dorsal wall of the coelom to a distance behind the anus equal to two-thirds the length of the liver. The left ovary is always slightly longer than the right. In the only specimen near breeding condition, there is a total of about 4,100 eggs, each measuring about .75 mm. in diameter. In addition there is at least an equal number of very minute eggs, each at most .14 mm. across. This circumstance makes it appear very probable that these deep-sea eels breed more than once.

Development

Material: Adolescents and transitional adolescents predominate in the Bermuda collections; larvae and post-larvae are absent:

Adolescents: 55 to 90 mm.—8 specimens (Figs. 3A, 4A).

Transitional Adolescents: 98 to 198 mm.—9 specimens (Figs. 3B, 4B).

Adults (Females): 255, 268 mm.—2 specimens (Figs. 3C, 4C).

Key to the Growth Stages:

A. Body more or less flattened, semi-leptocephaloid; pigment lacking ..... *Adolescent*

AA. Body of adult form; pigment present.

B. Gonads very inconspicuous, pigment incomplete or pale; skeleton not fully ossified *Transitional Adolescent*

BB. Gonads well developed; pigmentation complete; skeleton fully ossified ..... *Adult*

Changes Occurring During Growth: The smallest specimens (55 to 90 mm.) are typical eel adolescents, having no trace of larval teeth, the fins complete and in practically their final positions, and bodies, though somewhat flattened, well beyond the leptocephalid stage and almost as slender, relatively, as in the adults. The following differences are apparent, however, when compared with transitional adolescents and adults: Pigment is entirely lacking except for a line of minute chromatophores—doubtless remains of larval pigment—extending from

the anus to the caudal in the mid-line; this is lacking in larger adolescents. The body is otherwise perfectly white and opaque, except for rosy iridescence on the head, opercles, and, irregularly, along the sides; the abdomen is usually more brightly iridescent, with blue and violet tints predominating. In the largest adolescents there is a patch of pigment on the crown beneath the epidermis. The head is slightly larger than in older specimens; eye and snout, however, are of adult proportions. The teeth are feeble, but the full number is present, with the exception of the anterior cluster of vomerine teeth. The anal fin may originate very slightly in advance of the middle of the body, instead of at or behind this point. The finrays are more easily countable at this stage than later on, as the membranes are still thin. All of the pores, both cephalic and lateral line, are present, fully formed on the head but rudimentary along the lateral line. The striations are also developed, but are inconspicuous. The adolescent shows a moderate amount of ossification, the jaws and teeth being very strongly stained, and the jaw supports, hyoid and branchial arches, and pectoral girdle only slightly less firmly ossified. The brain-case, opercles, basal pectoral rays, vertebral column and external cephalic canal bones show moderate amounts of bony deposition in the larger adolescents, but in no specimen of this stage do the vertical fins, their baseosts or their radials show any trace of stain. In contrast to corresponding bones in the adult, the seventh branchiostegal ray is longest and strongest instead of shortest and weakest, while the urohyal is perfectly straight, instead of deeply curved. The digestive system differs from that of the adult only in the slightly shorter stomach, which in the smaller specimens ends a full snout's length in front of the anus. The gonads are rudimentary.

In the transitional adolescents (98 to 198 mm.) the entire skin is frequently tinged with warm pink, and true dark pigment first appears, spreading from the top of the neck backward, downward and forward. Specimens measuring 160 mm. and over are completely covered with pigment, but these fish are slightly paler than adults. There are small reductions in the length of the head and in the depth. The skeleton gradually becomes more strongly ossified. The digestive system does not

differ from that of the adult; the gonads are distinguishable, but very slightly developed.

The two fully adult specimens of the collection differ in proportions very little from the younger fish, as may be seen from the following summary of measurements made on all the specimens in the collection:

Growth Stage	Length / Depth	Length / Head	Length / Head minus Neck	Head / Eye	Head / Snout	Length / Snout to Dorsal	Length / Snout to Anal
Adolescent (55 to 90 mm.)	18— 25.7	6.5— 7	10— 11.8	8.2— 10.2	5— 6.4	3.9— 4.3	2— 2.3
Transitional Adolescent (98 to 198 mm.)	16.5— 25	6.5— 7.7	10.4— 12.5	7.1— 8.8	5.4— 6.7	3.7— 4.2	1.8— 2
Adult (255, 268 mm.)	19— 22.5	8.1— 8.4	14.5— 15	8.2— 8.8	5— 6.2	3.8— 4	1.8

Ecology

Seasonal Distribution: Eleven of the eighteen specimens were taken in September, four in June, three in August.

Vertical Distribution: *Derichthys* occurred only between 500 and 1,000 fathoms, at an average depth of 755 fathoms. No correlation is seen between season and depth.

Abundance: *Derichthys* is rare among the deep-sea fish of Bermuda, only one occurring in every 55 nets drawn between 500 and 1,000 fathoms, the Bermuda limits of its vertical distribution.

Sociability: Not more than a single specimen was ever taken in the same net.

Food: In five stomachs were traces of crustaceans, usually unquestionably shrimps and recognizable in one case as *Sergestes* sp. The latter measured 64 mm. in length, and had been swallowed tail first by a 132 mm. *Derichthys*. Unrecognizable remains of food were usually present in the intestines.

Enemies: A 198 mm. *Derichthys* had a number of parasitic worms embedded in the stomach wall.

Viability: No *Derichthys* has ever been taken alive.

Study Material

The following list gives the catalogue number, net, depth in fathoms, date, length and growth stage of each specimen of *Derichthys serpentinus* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described in Zoologica, Vol. XVI, No. 1, p. 5. "Trans. Adol." stands for "Transitional Adolescent."

No. 10,297; Net 148; 700 F.; June 1, 1929; 85 mm.; Adolescent.
No. 10,450; Net 167; 800 F.; June 14, 1929; 178 mm.; Trans. Adol.
No. 10,534; Net 177; 600 F.; June 17, 1929; 80 mm.; Adolescent.
No. 10,953; Net 219; 600 F.; June 25, 1929; 104 mm.; Trans. Adol.
No. 13,518; Net 475; 800 F.; Sept. 13, 1929; 159 mm.; Trans. Adol.
No. 13,712; Net 495; 800 F.; Sept. 23, 1929; 102 mm.; Trans. Adol.
No. 17,501; Net 822; 600 F.; Sept. 1, 1930; 58 mm.; Adolescent.
No. 17,778; Net 837; 600 F.; Sept. 3, 1930; 55 mm.; Adolescent.
No. 18,611; Net 890; 1,000 F.; Sept. 15, 1930; 62 mm.; Adolescent.
No. 19,281; Net 941; 1,000 F.; Sept. 24, 1930; 198 mm.; Trans. Adol.
No. 19,451; Net 953; 1,000 F.; Sept. 26, 1930; 133 mm.; Trans. Adol.
No. 19,547; Net 964; 600 F.; Sept. 29, 1930; 116 mm.; Trans. Adol.
No. 21,884; Net 1,121; 500 F.; Aug. 3, 1931; 98 mm.; Trans. Adol.
No. 22,680; Net 1,209; 1,000 F.; Aug. 20, 1931; 268 mm.; Adult.
No. 22,975; Net 1,244; 800 F.; Aug. 31, 1931; 255 mm.; Adult.
No. 23,110; Net 1,261; 600 F.; Sept. 4, 1931; 90 mm.; Adolescent.
No. 23,230; Net 1,278; 700 F.; Sept. 9, 1931; 79 mm.; Adolescent
No. 23,611; Net 1,317; 900 F.; Sept. 17, 1931; 104 mm.; Trans. Adol.

Synonymy and References

Derichthys serpentinus:

Gill, 1887, p. 433. (1 specimen; 8 in.; 1,022 fathoms; 39° 44′ 30″ N. Lat., 71° 04′ W. Long.; off New Jersey; *type specimen*).

Goode and Bean, 1895, p. 161, fig. 169. (Supplementary type description).

Parr, 1934, p. 32, fig. 10. (1 specimen; length not given; 1,050-1,100 metres; 25° 39′ N. Lat., 77° 18′ W. Long.; Bahamas. Discussion of synonymy of *D. iselini* with *D. serpentinus*.)

Derichthys iselini:

Borodin, 1929, p. 110. (1 specimen; 165 mm.; 1,000-0 fathoms; 50° 41′ N. Lat., 27° 17′ W. Long.; Middle North Atlantic, three-fifths of distance between Newfoundland and Scilly Isles).

Borodin, 1931, p. 75, pl. 3, figs. 4-6. (Supplementary type description).

Grammatocephalus kempi:

Norman, 1930, p. 339, fig. 34. (1 specimen; 160 mm.; 850-950 metres; 33° 50′ to 34° 13′ S. Lat., 16° 04′ to 15° 49′ E. Long.; off Cape Town).

Derichthys kempi:

Trewavas, 1932, p. 641, text-fig. 2 (Supplementary description of the type specimen of *Grammatocephalus kempi* and remarks on the relationships of the family.)

A bibliography will be found on p. 50 of the present volume.